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Invention: IMPROVEMENTS IN OR RELATING TO PUMP-ACTION NOZZLE DEVICES

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SPECIFICATION

IMPROVEMENTS IN OR RELATING TO PUMP-ACTION NOZZLE DEVICES

The present invention relates to improvements in or relating to pump-action nozzle devices.

Pump-action nozzle devices are commonly used as a means for dispensing a liquid from the interior of non-pressurised containers. Conventional pump-action nozzle devices are adapted to be fitted to an outlet opening of a container and comprise an internal chamber which is compressed when an actuator of the nozzle device is operated, thereby increasing the pressure within the chamber and forcing any liquid present therein to flow out through an outlet of the device. Once the desired volume of liquid has been dispensed, or the chamber has been compressed to its fullest extent, the actuator is then released by the operator and the chamber is allowed to re-expand, which causes the pressure within the chamber to reduce, which in turn causes more liquid to be drawn into the chamber from the associated container through an inlet. One-way valves are provided at the inlet and the outlet to ensure that fluid can only be expelled from the internal chamber through the outlet and drawn into the chamber through the inlet.

The actuator is typically a portion of the body of the nozzle device that can be depressed and subsequently released by an operator (generally known as pump nozzle devices), or a trigger that an operator can pull and then

subsequently release (generally known as trigger-actuated nozzle devices), to cause the chamber to be compressed and then re-expanded respectively.

There are a number of drawbacks associated with conventional pump-action nozzle devices. Firstly, the conventional devices tend to be extremely complex in design and typically comprise numerous different component parts (usually between 8 and 10 individual components in pump nozzle devices and between 10 and 14 individual components in trigger nozzle devices). As a consequence, these devices can be costly to manufacture due to the amount of material required to form the individual components and the assembly processes involved. Secondly, the conventional devices tend to be bulky (which again increases the raw material costs) and a proportion of this bulk is invariably disposed inside the container to which the device is attached. This creates a drawback in that the nozzle device takes up a proportion of the internal volume of the container, which can be a particular problem in small containers where the available space inside the container is limited. Finally, the size of the pump-action device is also dictated to certain extent by the size of the container to which it is attached. Thus, the size of the device is usually restricted in small containers, and especially small containers with narrow necks, and this limits the amount of pressure that can be generated by the device as well as the volume of fluid that can be dispensed, and, for this reason, can be detrimental to the performance of the device.

Therefore, there is a desire for a pump-action nozzle device which is:

(i) simpler in design;

(ii) utilises less components; and

(iii) is generally less bulky and costly to produce when compared with the conventional pump-action nozzle devices.

The present invention seeks to address the aforementioned problems associated with conventional pump-action nozzle devices by providing, in a first aspect, a pump-action nozzle device adapted to be fitted to a container and to enable fluid stored in the interior of said container to be dispensed during use, said device having a body which defines:

(i) an internal chamber;

(ii) an outlet through which fluid dispensed from said chamber is ejected from the device, said outlet further comprising an outlet valve configured to only open and permit fluid to be dispensed from the chamber when the pressure therein exceeds a predetermined minimum threshold pressure; and

(iii) an inlet through which fluid can be drawn into said chamber, said inlet further comprising a valve configured to only open and permit fluid to be drawn into the chamber when the pressure within the chamber falls below the external pressure,

wherein said body comprises a base portion and a housing portion, said base portion and housing portions together defining the internal chamber of the

device and being slidably mounted to one another such that said housing portion can be slid towards the base portion to reduce the internal volume of the chamber during a first stage of operation, thereby causing the pressure within the chamber to increase and any fluid stored therein to be dispensed through said outlet to be dispensed when the pressure therein exceeds the predetermined minimum threshold pressure required to open the outlet valve, and then slid away from the base to increase the volume of the chamber during a second stage of operation, thereby causing the pressure within the chamber to reduce and fluid to be drawn into the chamber through the inlet when the pressure within the chamber falls below the external pressure.

For the avoidance of doubt the expression "external pressure" is used herein to denote the pressure outside the device and may therefore include the pressure in the surrounding environment (atmospheric pressure) or the pressure within the container (which may differ from the atmosphere pressure).

When compared to conventional pump-action nozzle devices, the devices of the present invention are simpler in design/construction and comprise a reduced number of components. For instance, it is commonplace for the internal chamber of a conventional pump-action nozzle device to be a separate component part of the device which is fitted into the housing of the nozzle device and typically extends into the interior of the container. In the nozzle devices of the present invention, however, there is no separate internal chamber component because the chamber is defined by the base and housing

portions of the body. Similarly, the inlet and outlet valves are, in preferred embodiments, defined by the body of the nozzle arrangement, thereby obviating the necessity for numerous individual components to be present. This enables a functioning nozzle device to be moulded from a suitable material, such as plastic, and provides significant cost savings by reducing the amount material required to manufacture the devices, as well as reducing the construction/assembly costs. Furthermore, in preferred embodiments of the invention, the bulk of the device can be significantly reduced and the chamber can be positioned outside the container (or substantially outside of the container), thereby enabling the device to be fitted to the openings of containers of virtually any size, without the amount of pressure that can be generated being influenced by the size of the container and the constraints that this would impose of the dimensions of the device (as is the case with conventional pump nozzle devices).

The nozzle device of the present invention may be adapted to be fitted to a container by any suitable means. Preferably, it is the base portion of the nozzle device that is configured to be fitted to an opening of a container. In a preferred embodiment, the base comprises a cavity adapted to receive a correspondingly neck of the container which defines the opening of the container. The neck may be secured in the cavity by any suitable securing means. Preferably, the base is a screw top which can be fitted to an opening of the container (i.e. the neck of the container is provided with a screw thread that

is adapted to screw into a groove formed in the internal wall of the base, or vice versa).

Preferably, the base also defines the inlet of the device.

It is also preferred that an upper surface of the base (or a surface disposed on the opposing side of the base to the surface which is configured to be fitted to a container) forms an internal surface or wall of the chamber. Most preferably, the internal surface is an end wall or surface which is disposed outside the interior of the container. The remaining walls of the chamber are preferably formed by the housing, which is also preferably mounted onto the upper surface on the base. As a consequence, it will be appreciated that the chamber is defined between the base and housing will be substantially outside of the container to which the base is attached. Thus, although a small portion of the device may extend into the interior of the container, it is preferred that substantially entire internal chamber is positioned outside the container.

It is preferable, therefore, that the housing forms one or more internal walls of the chamber. In especially preferred embodiments of the invention, the base defines one end of the chamber and the housing defines the opposing end and a side wall of the chamber.

Preferably, the housing is slidably mounted within a recess or groove formed on an upper surface of the base (or a surface disposed on the opposing side of the base to the surface which is configured to be fitted to a container).

In certain preferred embodiments of the invention, the chamber of the device further comprises a plunger. The function of the plunger is primarily to enable virtually the entire contents of the chamber to be expelled when the volume of the internal chamber is reduced during the first stage of the operation of the device of the invention and to prevent any fluid leaking out between any gaps between the mounting of the housing and the base.

To enable the plunger to perform this function it must form a seal with the sides of the chamber to contain the fluid within a sealed portion of the chamber. In certain embodiments it is preferred that the plunger contacts the side wall of the chamber. In such embodiments of the invention, it is preferred that the plunger forms two seals with the wall of the chamber, namely a first seal which is formed where the plunger meets the side wall to define the sealed portion of the chamber and thereby prevents the product leaking past the plunger during the first stage of operation, and a second seal formed on the opposing side of the plunger which prevents air being drawn into the chamber (from gaps or leaks between the housing and the base) instead fluid being drawn in through the inlet during the second stage of operation of the device. The seal or seals must be maintained while the housing is moved relative to the base to facilitate the expansion and/or compression of the chamber. The plunger may be fixed to the housing within the chamber so that when the housing moves relative to the base during the operation the device, the plunger also moves. Preferably, however, the plunger is seated on an upper surface of

the base of the device so that the space within the sealed portion of the chamber is defined between said plunger and the internal walls of the housing. It will be appreciated that the plunger will remain stationery within the chamber in this position as the housing is slid relative to the base during the operation of the device.

The plunger may be made from any suitable material, such as rubber or plastics materials, for example. The plunger may be integrally formed with the base, but is preferably a separate component that may optionally be formed from a different material to that of the base.

In alternative preferred embodiments of the invention, the plunger may be replaced by a resiliently deformable insert which defines an internal sealed compartment which contains the fluid present in the chamber. Preferably the insert extends from one end of the chamber to the opposing end (as described further in reference to the accompanying drawing below). In such cases, the insert is configured to resiliently deform from an initial resiliently biased configuration when said housing is slid towards the base to compress the chamber, and return to its non-deformed or resilient biased configuration as the housing is returned to its original position and the internal volume of the chamber is increased.

Preferably, the nozzle device comprises a resilient means which is resiliently biased to urge said base and said housing apart. In certain preferred

embodiments of the invention, the resilient means is a spring disposed within the chamber. In alternative embodiments wherein the fluid present within the chamber is contained within a resiliently deformable insert, as discussed above, said insert forms the resilient means which is biased to urge the base and the housing apart. Preferably, cooperating detents provided on the base and the housing contact each other to limit the distance that the housing may slide away from the base.

Thus, in use, an operator wishing to dispense the contents of the container can apply pressure to the housing of the device against the action of the resilient means and thereby cause the volume of the internal chamber to be reduced and any fluid present therein to be dispensed through the outlet. Once the pressure applied by the operator to the housing has been released, the resilient means urges then urges the housing and the base apart and thus causes the contents of the container to be drawn into the chamber of the device ready for the next actuation by the operator.

Preferably, at least a portion of the internal passageway of the outlet is defined between the abutment surfaces of two or more component parts of the nozzle device.

In certain embodiments of the invention a portion of the internal passageway may be defined by just one of said component parts. In preferred embodiments of the invention, however, each of said parts has an abutment surface which contacts opposing abutment surfaces of the other parts when the

respective parts are contacted together in the assembled nozzle device and at least one of the abutment surfaces has one or more groove and/or recesses formed thereon which defines the internal passageway when said parts are contacted together.

It is most preferred that the at least a portion of the internal passageway is defined between two component parts of said body. In such cases, the at least a portion of the passageway is defined between opposing abutment surfaces of said two parts and at least one of said abutment surfaces has one or more grooves and/or recesses formed thereon which define the passageway when the abutment surfaces of the two parts are contacted together. Most preferably, both of said abutment surfaces have one or more grooves and/or recesses formed thereon which align to define said passageway when the abutment surfaces of said parts are contacted together.

Examples of nozzle devices formed of two separate parts having abutment surfaces which define an internal passageway of a nozzle device are described in WO 01/89958 and W0 97/31841, and the entire contents of these documents are incorporated herein by reference.

The outlet valve may be any suitable valve assembly configured to only open and permit fluid to flow through the outlet when the volume of the chamber is reduced and the pressure therein exceeds a predetermined minimum threshold pressure. The minimum threshold pressure required will depend on the application of the nozzle device. For instance, the threshold pressure may

be set very low if the product is to be dispensed slowly or gradually (as is the case with, for example, soaps, creams etc.) whereas the threshold pressure may be much higher if the nozzle device is to be used to generate a spray. In the latter case, the contents of the chamber may be ejected at a pressure of 6 bars, for example, and in such cases the minimum threshold pressure of the outlet valve may be set at 5 bars. The outlet valve could be a ball valve, for example, where the ball is displaced to open the valve when the pressure within the chamber exceeds a predetermined minimum threshold.

In preferred embodiments of the invention, however, the outlet valve is defined by the body of the nozzle arrangement.

Furthermore, in preferred embodiments of the invention wherein the outlet comprises a outlet orifice and an internal passageway, at least a portion of which is defined between the abutment surfaces of two or more parts of the nozzle device, the outlet valve is preferably formed within said portion of the internal passageway that is defined between the abutment surfaces of two or more parts of the nozzle device, although it may also be formed in a portion of the internal passageway that is defined by just one of said parts. Most preferably, the valve comprises a valve member that is formed on one of the component parts, said valve member being resiliently biased against the opposing surface of the other component part or parts, thereby closing the internal passageway formed there between, and being configured to be displaced so as to define an open channel through which fluid can flow when

the pressure within the chamber exceeds a predetermined minimum threshold pressure.

Preferably, the valve member is in the form of a resiliently deformable flap that is mounted to one of said component parts and is resiliently biased into a configuration whereby the flap extends across the internal passageway and closes the passageway. The flap is further configured to resiliently deform when the pressure within the chamber is at or exceeds a predetermined minimum threshold pressure to define an opening or channel through which fluid from the chamber can flow along the internal passageway to the outlet orifice, where it is ejected in the form of a spray. The flap may simply extend across the passageway, but it is preferable that the flap is resiliently biased against an opposing abutment surface or surfaces, which define the internal passageway. It is especially preferred that the flap is mounted within a chamber formed within the internal passageway. The chamber provides sufficient space for the flap to be deflected from its resiliently biased position to open the valve when the pressure within the chamber is at or exceeds the predetermined minimum threshold. The flap will also be configured so that it can only be distended by fluid pressure acting towards the outlet and not in the opposite direction, there by making the valve a one-way outlet valve.

Alternatively, the valve member is in the form of a plug which is resiliently biased into a position in which the plug blocks the internal passageway, but is configured to also be displaced to define an opening or

channel through which fluid can flow when the when the pressure within the chamber is at or exceeds the predetermined minimum threshold. Although the plug itself may be configured to deform so as to define a channel or opening through which fluid can flow when the pressure within the chamber (and acting on the plug) is at or exceeds the predetermined minimum threshold, it is most preferable that the plug is mounted to a resiliently deformable surface which can deform to withdraw the plug from the internal passageway when the requisite pressure within the chamber has been achieved.

As a further alternative, the valve member may be adapted to resiliently collapse or otherwise deform, thereby forming a channel through which fluid can pass when a minimum pressure within the chamber has been achieved.

The valve member and/or the surface on which it is mounted may be made from any suitable resiliently deformable material, such as a deformable plastic material or a rubber material.

The outlet orifice is positioned at the end of the internal passageway. Preferably, the outlet orifice is formed at an edge of the abutment surfaces of the at least two parts.

In a preferred embodiment of the invention, the outlet is defined by the housing portion of the body. Preferably, the housing comprises two component parts and said at least a portion of the internal passageway of the outlet is defined between the two component parts of the housing. In an especially preferred embodiment of the invention the housing comprises a first component

part that defines the internal chamber together with the base and comprises an aperture which forms an initial section of the internal passageway, and a second component part which is fitted to the first part to such that abutment surfaces of said first and second parts are contacted together to define the remainder of the internal passageway there between.

In embodiments of the invention which are adapted to generate a spray of the fluid dispensed through the outlet during use, it is preferable that the internal passageway further comprises one or more internal spray-modifying features. As an alternative, the nozzle device may be configured to receive an insert which comprises one or more spray-modifying features. The insert can be positioned in relation to the nozzle device so that fluid exiting the outlet orifice flows into an inlet of said insert and through an internal passageway comprising the one or more internal spray modifying features formed therein to an outlet orifice of the insert where the fluid is ejected.

Suitable spray-modifying features that may be incorporated within the internal fluid flow passageway or present in an insert fitted thereto are known in the art and are described further in, for example, International Patent Publication No. WO 01/89958, the entire contents of which are incorporated herein by reference. Illustrative examples of such features include one or more features selected from the group consisting of: an expansion chamber, a swirl chamber, an internal orifice, multiple passageway branches, a dog-leg arrangement (where the passageway comprises a turn in one direction, typically

through ninety degrees, followed by a turn back in the opposing direction), a venturi chamber (where air is drawn into the fluid stream by venture), an outlet orifice in the form of a slit, or multiple outlet orifices.

It is preferable that outlet valve is positioned before (or upstream from) the one or more spray modifying features, such that fluid can only flow through the spray modifying features when the pre-compression valve is open.

The inlet valve may be any suitable valve assembly which enables the contents of the container to flow into the chamber of the device only when the pressure within the chamber falls below the external pressure, but which prevents flow in the other direction during the first stage of operation of the device. In certain embodiments of the invention, the plunger is seated on the upper surface of the base and comprises valve member or stem which extends from the main body of the plunger and is received in a sealing engagement with a valve seat formed in the base. In alternative embodiments, the valve member or stem may be a separate component, i.e. it is not integrally formed with the plunger. During the second stage of operation, the valve member or stem is displaced from the valve seat to form an opening through which the contents of the container may flow into the chamber of the device when the pressure within the chamber falls below the external pressure.

In order to prevent the container to which the device is attached from collapsing when fluid is dispensed from the interior of the container and the pressure therein is reduced, it is preferable that the device comprises an air leak

valve configured to enable air from the external environment to access the interior of the container to equalise any pressure differential that exists between them. Any suitable form of air leak would suffice. Preferably, however, the air leak valve is a one-way valve, which enables air to flow into the container from the outside, but prevents fluid flow in the opposite direction, and hence, prevents any product in the container from leaking out through the air leak valve if the container is inverted, for example. Illustrative examples of suitable air leak valve arrangements formed in the device of the present invention are described below in reference to Figures 9A, 9B and 9C.

Preferably, a dip tube is fitted to the base to enable a product stored in the container to be drawn into the device from the interior of the container.

For certain applications, it is desirable to co-eject air together with the contents of the container passing through the nozzle outlet. For instance, the air could be mixed with the product to impart a certain consistency to the product, which is desirable for certain products, such as, for example, foams or mousses. Alternatively a pressurised air stream could be used to atomise droplets of liquid passing through the nozzle outlet to create a fine spray. For this latter application it is especially desirable to be able to introduce an air stream at a predetermined location along the length of the fluid flow passage of the nozzle outlet. Hence, in certain embodiments of the invention, the chamber of the device is divided into two separate compartments, a first of said compartments comprising the inlet valve and the outlet valve and being configured dispense

fluid drawn in through the inlet of the device during the first and second stages of operation, and a second of said compartments being a separate an air compartment or chamber configured to a eject a stream of air through the nozzle outlet during the first stage of operation and draw air in from the outside during a second stage of operation. Hence, the movement of the housing relative to the base to cause the compression of the chamber during the first stage of operation in such embodiments causes the contents of the container to be dispensed through the nozzle outlet in the usual manner, and additionally forces air from the second compartment though an outlet channel into the nozzle outlet, where the mixing of the air with the contents of the container passing through the nozzle outlet occurs.

Preferably, the said air chamber is provided with an outlet valve configured to only open and permit a stream air to flow through the outlet of the nozzle arrangement when the pressure within the air compartment exceeds a predetermined minimum pressure.

In preferred embodiments of the invention wherein the outlet comprises an outlet orifice and an internal passageway, the air stream ejected from said air compartment/chamber during the first stage of operation may be introduced into said internal passageway at any position along its length through an outlet channel of the air compartment.

It is also preferred that the nozzle device further comprises an air inlet

valve configured to open and permit air to access the air compartment only when the pressure therein falls below the external pressure. Therefore, during the second stage of operation of the device, air is drawn into the air chamber from the external environment through a one-way air inlet valve which allows air to access the air compartment of chamber when the pressure in the chamber is decreased relative to that of the external environment, i.e. when the volume of the chamber is increased by moving the housing and the base apart, but prevents the flow of air in the opposite direction during the first stage of operation. The air may be drawn into the air chamber/compartment through the nozzle, outlet and/or through gaps formed between the housing and the base and/or a designated air inlet.

Preferably, the first compartment comprises a plunger as discussed above and the second air chamber/compartment is also provided with an air plunger. Preferably, the air plunger is adapted to form a seal with the housing which prevents the air present in the air chamber/compartment from leaking past the air plunger during the first stage of operation, but which allows air to flow past during the second stage of operation.

In a preferred embodiment, the air inlet valve also functions as the air release between the interior of the chamber and the external environment.

The nozzle devices of the present invention are preferably formed from plastic. The component parts of the nozzle arrangement may be moulded

individually and then connected together to form the assembled nozzle arrangement. Alternatively, some or all of the components may be formed by a bi-injection moulding process whereby a first component is moulded during a first moulding stage and a second component part is then moulded onto the first component part during a second moulding stage. The first and second component parts may be made from the same or a different material.

In embodiments where the housing is composed of two component parts, each component part may be made moulded separately and then joined together or by a bi-injection moulding process, as described above. As an additional alternative, the two component parts may be connected to one another by a hinge or foldable connection element and moulded in a single moulding operation and then folded over about said hinge or connection element to form the assembled housing component.

The respective parts, once formed, may be permanently fixed together or, alternatively, the parts may be releasably connectable to one another. This latter form of assembly is preferred because it enables the respective parts to be separated to expose the interior of the nozzle device for cleaning.

The device of the present invention may also be provided with a trigger actuator which enables the first and second stages of operation to be facilitated by the operation of a trigger, rather than applying pressure to the housing directly. The trigger actuator is preferably configured so that, when the trigger

is pulled, the housing of the device is caused to move towards the base and compress the chamber of the device formed there between, thereby causing the pressure within the chamber to increase and the fluid present therein to be dispensed through the nozzle outlet. When the trigger is released, the housing is free to move away from the base so as to cause the volume of the chamber to expand and thereby draw more product (and air if an air compartment is present) into the chamber.

Preferably, the trigger actuator is a separate component that is fitted to the pump-action nozzle device and which comprises a trigger handle and two attachment elements. Preferably, a first attachment element fixes the actuator to the base and a second attachment element attaches the trigger actuator to the housing, said elements being moveable towards each other when the trigger is pulled and moveable apart from each other when the trigger is released and returned to its original position.

Preferably, one attachment element is integrally formed with the trigger and is pivotally attached to the base of the device and the other attachment element, the other attachment element being pivotally mounted to the housing of the device.

According to a second aspect of the present invention there is provided a trigger actuator adapted to be fitted to a pump nozzle device comprising an internally compressible chamber formed between a housing and a base of the

device, said housing being moveable relative to the base to facilitate the expansion of the internal chamber in a first stage of operation and the compression of the chamber in a second stage of operation, said trigger actuator comprising a trigger handle and means by which the trigger actuator may be connected to the base and means by which the trigger actuator may be attached the housing, wherein said trigger actuator is configured so that when the trigger is pulled towards the nozzle device said housing is caused to move relative to the base and compress the chamber during the second stage of operation and when said trigger is released said housing is caused to move relative to the base to expand the chamber during the first stage of operation.

Thus, the trigger actuator provides a means by which a pump nozzle device may be converted into a trigger actuated pump-action nozzle device.

The trigger actuator is preferably formed as discussed above.

In more general terms, it can be particularly desirable to co-eject air from a pump-action nozzle device because, in the case of devices adapted to generate a spray (e.g. finger pump and trigger spray nozzle devices), the quality of the spray produced at low pressures can often be poor and the mixing of the fluid with an air stream provides a means by which the spray droplets ejected from the nozzle device can be further atomised prior to ejection from the nozzle device. In addition, it can also be desirable to introduce air into a low pressure dispenser which is dispensing a product such as a foam or mousse. Although it

is commonplace to co-eject air from industrial scale nozzle devices where high volumes of air and high pressures are can be used, it is less common (although not unknown) to co-eject air with another fluid from a pump-action nozzle device. This is because the amount of air that can be contained in such devices is limited (up to a maximum of 10 times the volume of liquid dispensed and more typically between 5 and 10 times the volume of liquid) and the pressure generated by such devices is typically low (between 3 and 6 bars).

Conventional nozzle devices (commonly referred to as air pumps) are generally large complex structures that are difficult to manufacture, particularly at low cost (due to the material and assembly costs involved). It is a further object of the present invention, therefore, to provide a pump-action nozzle arrangement which can co-eject air together with another fluid from a container and which is also simple and compact nozzle device that is inexpensive to produce and comprises only a few separate components.

Hence, according to a third aspect of the present invention there is provided a pump-action nozzle device adapted to be fitted to an opening of a container and enable a liquid to be dispensed from the interior of said container during use, said nozzle device having a body which defines an internal chamber and which comprises:

(i) an inlet having a one-way valve through which fluid can be drawn into said chamber;

(ii) an outlet orifice;

(iii) an internal passageway that connects said chamber to said outlet orifice;

(iv) a one-way outlet valve disposed in said internal passageway and adapted to only open and permit fluid to flow along said passageway when the pressure within the internal chamber exceeds a predetermined minimum pressure; and

(iv) an actuator;

wherein said body is configured such that the internal volume of the chamber is reduced when said actuator is operated, thereby causing fluid stored in the chamber to be ejected through said outlet valve and along said internal passageway to the outlet orifice, and increased when said actuator is released, thereby causing fluid to be drawn into the chamber through the inlet;

characterised in that said body further defines an air chamber configured to dispense a stream of air into said internal passageway or said outlet orifice when said actuator is operated through an outlet channel which connects said air chamber to a position along said internal passageway or said outlet, said body being configured such that the internal volume of the chamber is reduced when said actuator is operated, thereby causing air present in the air chamber to be ejected through said outlet channel and into said internal passageway or said outlet orifice, and increased when said actuator is released, thereby causing air to be drawn into the air chamber from the external environment.

Preferably the nozzle devices of the third aspect of the present invention comprise one or more features of the nozzle arrangements of the first aspect of the present invention defined above (even if no specifically reiterated below).

During the normal operation of the device of the third aspect of the present invention, the actuator is operated to compress both the internal chamber of the device and the air chamber to cause fluid present in the internal chamber and air present in the air chamber, respectively, to be dispensed through the outlet orifice. Once the actuator is then released, the volume of the chambers can be increased to cause fluid to be drawn into the internal chamber through the inlet of the device and air to be drawn into the air chamber.

It is preferable that one or more of the internal chamber, inlet (and inlet valve), outlet valve (and outlet valve) are defined by the body of the device, as discussed above. Most preferably, all of the aforementioned components are defined by the body of the device. Thus, in such embodiments, the device of the third present invention is simpler in design/construction and comprises a reduced number of components. Furthermore, in preferred embodiments of the invention, the bulk of the device can be significantly reduced and the chamber can be positioned outside the container (or substantially outside of the container), thereby enabling the device to be fitted to the openings of containers of virtually any size, without the amount of pressure that can be generated being influenced by the size of the container and the constraints that this would

impose of the dimensions of the device (as is the case with conventional pump nozzle devices).

Preferably, the device comprises a resilient means configured to cause the volume of the chamber to increase once the actuator is released.

Preferably, the body of the device comprises two component parts that can be moved towards one another to compress the internal chamber and the air chamber, and away from one another to cause the chamber to expand. The resilient means is preferably biased against both of said parts to urge the two parts away from one another. The resilient means may be a spring or other resiliently deformable insert provided in one or both said internal chamber and said air chamber.

The air chamber may be a separate compartment of the internal chamber or may be a separate chamber altogether.

Air may be drawn into the air chamber through outlet orifice and the internal passageway of the device and into the air chamber through the outlet channel when the actuator is released and the volume of said chamber is caused to increase/expand. In such cases, air is prevented from accessing the internal chamber by the one-way outlet valve. Preferably, however, the device may further comprise an air inlet through which air is drawn into the air chamber from outside the device. The air inlet preferably comprises an air inlet valve configured to only open and permit air to be drawn into the chamber when the

pressure therein falls below the external pressure (i.e. when the volume of the chamber is caused to increase).

The outlet channel may be one or more fine holes or pores which permit air to flow through but prevent any liquid from the internal chamber flowing through the internal passageway from accessing the air chamber. Most preferably, however, the outlet channel comprises an air release valve adapted to only open and permit fluid to flow along said passageway when the pressure within the air chamber exceeds a predetermined minimum pressure. Any suitable air release valve may be used. In embodiments of the third aspect of the invention where air is drawn into the air chamber through the outlet orifice and the internal passageway, the air release valve will be a two-way valve configured to permit air to flow out of the air chamber when the pressure within the chamber exceeds a predetermined minimum pressure, and flow into the air chamber when the pressure therein falls below the external pressure. In embodiments of the third aspect of the invention where air is drawn into the air chamber through a separate air inlet, the air release valve is preferably a one way valve configured to only open and permit air to flow out of the air chamber when the pressure therein exceeds a predetermined minimum.

Preferably, the outlet valve and the air release valve are configured to open at substantially the same minimum threshold pressure. This ensures that the fluid from the internal chamber and the air from the air chamber are both

released at the same time. Clearly this can be modified to enable either the air or liquid to be dispensed first if this is desired.

Preferably, the internal passageway is separated from said air chamber by a wall of the body and said outlet channel is formed in said wall at any desired position so that air can be ejected into said internal passageway at any desired position along the length of the internal passageway.

In preferred embodiments of the third aspect of the invention the chamber is positioned either above or below the internal passageway and said outlet channel is formed in an upper or lower wall of the chamber respectively.

Preferably the outlet channel is positioned so that air is introduced into the internal passageway downstream from the outlet valve (i.e. it is introduced at a position between the outlet valve and the outlet orifice).

Preferably, at least a portion of the internal passageway of the outlet is defined between the abutment surfaces of two or more component parts of the nozzle device.

In certain embodiments of the third aspect of the invention a portion of the internal passageway may be defined by just one of said component parts. In preferred embodiments of the third aspect of the invention, however, each of said parts has an abutment surface which contacts the abutment surfaces of the other parts when the parts are contacted together in the assembled nozzle device, and at least one of said abutment surfaces has one or more groove

and/or recesses formed thereon which define said internal passageway between the abutment surfaces when said parts are contacted together. It is most preferred that the at least a portion of the internal passageway is defined between two component parts of said body. In such cases, the at least a portion of the passageway is defined between opposing abutment surfaces of said two parts and at least one of said abutment surfaces has one or more grooves and/or recesses formed thereon which define said passageway when the abutment surfaces of said parts are contacted together. Most preferably, both of said abutment surfaces have one or more grooves and/or recesses formed thereon which align to define said passageway when the abutment surfaces of said parts are contacted together.

Examples of nozzle devices formed of two separate parts which define an internal passageway of the device are described in WO 01/89958 and W0 97/31841, and the entire contents of these documents are incorporated herein by reference.

The outlet valve may be any suitable valve assembly configured to only open and permit fluid to flow through the outlet when the volume of the chamber is reduced and the pressure therein exceeds a predetermined minimum threshold pressure. The minimum threshold pressure required will depend on the application of the nozzle device. For instance, the threshold pressure may be set very low if the product is to be dispensed slowly or gradually at a low pressure (as is the case with, for example, soaps, creams etc.) whereas the

threshold pressure may be much higher if the nozzle device is to be used to generate a spray. In the latter case, the contents of the chamber may be ejected at a pressure of 6 bars, for example, (although it could be as low as 2 to 3 bars in some cases) and in such cases the minimum threshold pressure of the outlet valve may be set at 5 bars. The outlet valve could be a ball valve, for example, where the ball is displaced to open the valve when the pressure within the chamber exceeds a predetermined minimum threshold. In a preferred embodiment of the third aspect of the invention, however, the outlet valve is a flap valve in which the flap is resiliently mounted so as to reside in a position in which a channel between the chamber and nozzle outlet is closed (i.e. the valve is closed), but may be distended to a position in which said channel is open (i.e. the valve is open) when the pressure within the chamber exceeds the predetermined minimum threshold pressure.

In preferred embodiments of the third aspect of the invention wherein the outlet comprises a outlet orifice and an internal passageway, at least a portion of which is defined between the abutment surfaces of two or more parts of the nozzle device, the outlet valve is preferably formed by said portion of the internal passageway that is defined between the abutment surfaces of two or more parts of the nozzle device, although it may also be formed in a portion of the internal passageway that is defined by just one of said parts. Most preferably, the valve comprises a valve member that is formed on one of the component parts, said valve member being resiliently biased against the

opposing surface of the other component part or parts, thereby closing the internal passageway formed there between, and being configured to be displaced so as to define an open channel through which fluid can flow when the pressure within the chamber exceeds a predetermined minimum threshold pressure.

Preferably, the valve member is in the form of a resiliently deformable flap that is mounted to one of said component parts and is resiliently biased into a configuration whereby the flap extends across the internal passageway and closes the passageway. The flap is further configured to resiliently deform when the pressure within the chamber is at or exceeds a predetermined minimum threshold pressure to define an opening or channel through which fluid from the chamber can flow along the internal passageway to the outlet orifice, where it is ejected in the form of a spray. The flap may simply extend across the passageway, but it is preferable that the flap is resiliently biased against an opposing abutment surface or surfaces, which define the internal passageway. It is especially preferred that the flap is mounted within chamber formed within the internal passageway. The chamber provides sufficient space for the flap to be deflected from its resiliently biased position to open the valve when the pressure within the chamber is at or exceeds the predetermined minimum threshold.

Alternatively, the valve member is in the form of a plug which is resiliently biased into a position in which the plug blocks the internal

passageway, but is configured to also be displaced to define an opening or channel through which fluid can flow when the when the pressure within the chamber is at or exceeds the predetermined minimum threshold. Although the plug itself may be configured to deform so as to define a channel or opening through which fluid can flow when the pressure within the chamber (and acting on the plug) is at or exceeds the predetermined minimum threshold, it is most preferable that the plug is mounted to a resiliently deformable surface which can deform to withdraw the plug from the internal passageway when the requisite pressure within the chamber has been achieved.

The valve member and/or the surface on which it is mounted may be made from any suitable resiliently deformable material, such as a deformable plastic material or a rubber material.

In general it is preferable that the outlet valve is defined by the body of the device rather than being a separate component. Thus, one part of the body comprises a valve member formed thereon as an integral component, which shuts off or closes the internal passageway but which can be displaced to open the valve when the pressure within the chamber exceeds the predetermined minimum threshold pressure.

The outlet orifice is positioned at the end of the internal passageway. Preferably, the outlet orifice is formed at an edge of the abutment surfaces of the at least two parts

In embodiments where the internal passageway is defined by two or more abutment surfaces (preferably two abutment surfaces), the outlet channel of the air chamber extends from a position on one of said abutment surfaces to the air chamber.

In embodiments of the third aspect of the invention which are adapted to generate a spray of the fluid dispensed through the outlet during use, it is preferable that the internal passageway further comprises one or more internal spray-modifying features. As an alternative, the nozzle device may be configured to receive an insert which comprises one or more spray-modifying features. The insert can be positioned in relation to the nozzle device so that fluid exiting the outlet orifice flows into an inlet of said insert and through an internal passageway comprising the one or more internal spray modifying features formed therein to an outlet orifice of the insert where the fluid is ejected.

Suitable spray-modifying features that may be incorporated within the internal fluid flow passageway or present in an insert fitted thereto are known in the art and are described further in, for example, International Patent Publication No. WO 01/89958, the entire contents of which are incorporated herein by reference. Illustrative examples of such features include one or more features selected from the group consisting of: an expansion chamber, a swirl chamber, an internal orifice, multiple passageway branches, a dog-leg arrangement (where the passageway comprises a turn in one direction, typically

through ninety degrees, followed by a turn back in the opposing direction), a venturi chamber (where air is drawn into the fluid stream by venture), an outlet orifice in the form of a slit, or multiple outlet orifices.

It is preferable that outlet valve is positioned before (or upstream from) the one or more spray modifying features, such that fluid can only flow through the spray modifying features when the pre-compression valve is open.

It is also especially preferred that the outlet channel is arranged to introduce air into an internal chamber formed in the internal passageway or the insert (whereby the outlet channel may align with a hole formed in the insert through which the air can flow into the insert). Such a chamber may be an expansion chamber or a swirl chamber.

The inlet valve may be any suitable valve assembly which enables the contents of the container to flow into the chamber of the device only when the pressure within the chamber falls below the external pressure, but which prevents flow in the other direction during the first stage of operation of the device.

The actuator may be any suitable means by which the compression and subsequent re-expansion of the chamber may be facilitated. For instance, the actuator may be a portion of the body that can be pressed by an operator to facilitate the compression of the chamber, or the nozzle arrangement may further comprise a trigger actuator that can be pulled by an operator to facilitate the compression of the chamber.

In order to prevent the container to which the device is attached from collapsing when fluid is dispensed from the interior of the container and the pressure therein is reduced, it is preferable that the device comprises an air leak valve configured to enable air from the external environment to access the interior of the container to equalise any pressure differential that exists between them. Any suitable form of air leak would suffice. Preferably, however, the air leak valve is a one-way valve, which enables air to flow into the container from the outside, but prevents fluid flow in the opposite direction, and hence, prevents any product in the container from leaking out through the air leak valve if the container is inverted, for example. Illustrative examples of suitable air leak valve arrangements formed in the device of the present invention are described below in reference to Figures 9A, 9B and 9C.

The nozzle devices of the third aspect of the present invention are preferably formed from plastic. The component parts of the nozzle arrangement may be moulded individually and then connected together to form the assembled nozzle arrangement. Alternatively, some or all of the components may be formed by a bi-injection moulding process whereby a first component is moulded during a first moulding stage and a second component part is then moulded onto the first component part during a second moulding stage. The first and second component parts may be made from the same or a different material.

In embodiments where the housing is composed of two component parts, each component part may be made moulded separately and then joined together or by a bi-injection moulding process, as described above. As an additional alternative, the two component parts may be connected to one another by a hinge or foldable connection element and moulded in a single moulding operation and then folded over about said hinge or connection element to form the assembled housing component.

The respective parts, once formed, may be permanently fixed together by, for example, ultrasonic welding, or alternatively, the parts may be releasably connectable to one another. This latter form of assembly is preferred because it enables the respective parts to be separated to expose the interior of the nozzle device for cleaning

How the invention may be put into effect will now be described further by way of example only in reference to the following Figures, in which:

Figure 1A is a cross-sectional view taken through a first embodiment of a device of the present invention;

Figure 1B is an exploded cross-sectional view showing the components which make up the device shown in Figure 1A;

Figure 2A is a cross-sectional view taken through a second embodiment of a device of the present invention;

Figure 2B is an exploded cross-sectional view showing the components

which make up the device shown in Figure 2A;

Figure 3A is a cross-sectional view of the housing 102 shown in Figures 2A and 2B;

Figure 3B is a plan view of the underside of the housing 102 shown in Figures 2A and 2B;

Figure 4 is a plan view of the base 101 shown in Figure 2A;

Figure 5A is a cross-sectional view of the plunger 108 shown in Figures 2A and 2B;

Figure 5B is a plan view of the plunger 108 shown in Figures 2A and 2B;

Figures 6A and 6B are both cross-sectional views showing the top portion of the housing shown in Figure 2A and 2B nozzle outlet with the lid 104 partly displaced from the housing (Figure 6A) and in contact with the housing 102 (Figure 6B);

Figure 7A is a cross-sectional view of the nozzle outlet 106 shown in Figures 2A and 2B;

Figure 7B is a perspective view of the recess 704 shown in Figure 7A;

Figure 7C is a cross-sectional view taken along line X-X' of Figure 7A in an assembled nozzle outlet;

Figure 8 is a cross-sectional diagrammatical view taken through the

upper portion of the housing 102 of an alternative embodiment of the present invention which incorporates an alternative version of the second valve;

Figures 9A to 9c are cross-sectional diagrammatical views showing various embodiments of an air leak valve;

Figure 10A is a cross-sectional view of a device of the present invention which is fitted with a trigger actuator;

Figure 10B is a cross-sectional view of the device shown in Figure 8A when the trigger has been pulled to cause the housing to move relative to the base;

Figure 11 is a cross-sectional view taken through the housing 102 of an alternative embodiment of the present invention;

Figure 12A is an exploded cross-sectional view of a further alternative embodiment of the present invention;

Figure 12B is a cross-sectional view of the assembled nozzle arrangement shown in Figure 12A;

Figure 13 is a cross-sectional view of a further alternative embodiment of the present invention; and

Figure 14 is a cross-sectional view to yet another alternative embodiment of the invention.

Figures 1 to 14 all exemplify the first aspect of the present invention.

Figures 10A and 10B exemplify the second aspect of the present invention and Figures 2A to 8, 13 and 14 exemplify the third aspect of the present invention.

In the following description of the Figures, like reference numerals will be used to denote like or corresponding parts in different Figures.

A first embodiment of a device 100 according to the present invention is shown in Figures 1A and 1B. The device 100 comprises a base 101 which defines a cavity 150, the internal walls of which are provided with a screw thread 151 formed therein. This internal cavity 150 is adapted to receive a corresponding shaped and screw-threaded neck of a container, thereby enabling the device 100 to be screwed onto the container for use.

The device 100 further comprises a housing 102 which is slidably mounted within a recessed groove 103 formed on the upper surface of the base 101. The groove 103 of the base is provided with detents (in this case an inwardly projecting rim 101a) which abut co-operating detents (in this case an outwardly projecting rim 102a) formed on the housing 102 to limit the upward movement of the housing relative to the base and thereby prevent the housing from sliding out of engagement with the base during use.

The base 101 and housing 102 together define an internal chamber 107 in which a plunger 108 is disposed. The plunger 108 is seated on the base 101 and extends across the entire width of the chamber 107 to abut the side walls of the chamber formed by the housing 102 and form a sealing engagement

therewith.

The plunger 108 also comprises an integrally formed, downwardly extending valve member 108a, which is received within a valve seat 109 formed in the base 101. The valve member 108a, together with the valve seat 109, form the so-called inlet valve of the device between the chamber and the interior of the container. An inlet channel 110 is also formed in the base 101 and a dip tube (not shown) is fitted to this channel to enable the contents of the container to be drawn into the chamber 107 of the device 100 through the inlet valve during use, as described further below.

The housing 102 comprises a first part 102c which defines the internal chamber 107 and additionally comprises a second part in the form of a lid 104. The first part 102c defines an upper wall 102d and side wall 102e of the chamber, as well as an initial portion 106a of the internal passageway 106. The remainder of the internal passageway 106 is defined between respective abutment surfaces of the lid 104 and the first part of the housing 102c. In this regard, the abutment surfaces of the first part 102c and the lid 104 comprises recesses and/or grooves formed thereon which align when the respective abutment surfaces are contacted together to define the remainder of the internal passageway 106. An outlet orifice 112 is formed where the grooves/recesses meet the edge of the abutment surfaces of the housing 102c and the lid 104.

A one-way outlet valve is formed within the internal passageway defined

by the abutment surfaces of the lid 104 and the first part of the housing 102c. In this regard, the lid 104 is provided with a resiliently mounted flap 105 which sits in a chamber 105a formed in the internal passageway to form the outlet valve. The flap 105 is resiliently biased against the upper surface of the first part on the housing 102a to close the internal passageway 106, but can be displaced towards the outlet 112 when the pressure within the chamber exceeds a predetermined minimum threshold pressure. The outlet valve is a one-way valve because the flap cannot be displaced towards the chamber 107.

A coiled spring 111 is positioned within the chamber 107. The spring is biased at one end against the housing 102 and the base 101 at its other end. The housing additional comprises a support member 102b which extends downwards from its upper surface and is positioned inside the bore defined by the coiled spring 111. The support member 102b provides support to the spring and also enables the spring to be kept in place while the device is assembled.

The spring urges the housing 102 upwards and away from the base so that the rim 102a of the housing abuts the internal rim 101a of the base, thereby limiting the extent of upward movement of the housing 102. In this position (and as shown in Figure 1A) the internal chamber 107 possesses its maximum internal volume. During use, the lid 104 of the housing 102 can be pressed downwards by an operator so as to cause the housing 102 to slide towards the base 101, against the action of the spring 111. During this movement, the

internal volume of the chamber 107 is reduced and this in turn results in the compression of the chamber 107. The resultant increase in pressure in the chamber pushes the valve member 108a of the plunger into a sealing engagement with the valve seat 109, thereby closing the inlet valve and preventing the contents of the chamber flowing from the chamber 107 into the interior of the container. Furthermore, once the pressure within the chamber reaches a predetermined minimum threshold value, for example 5 bars, the contents of the container cause the resiliently mounted flap 105 to be displaced from a position in which the outlet is blocked to a position in which the outlet is open, thereby enabling the contents stored within the chamber 107 to flow through the outlet valve, along the internal passageway 106 and then be dispensed from the device through the outlet orifice 112.

Once the desired amount of product has been dispensed or the housing has been depressed to its fullest extent so that the maximum quantity of product has been dispensed from the chamber, then the operator will release the pressure applied to the housing and the housing will slide back to its initial position (as shown in Figure 1A) under the action of the spring 111. In doing so the internal volume of the chamber 107 increases and this creates a reduced pressure within the chamber 107. The outlet valve is closed during this process because once the pressure falls below the minimum threshold, the resiliently mounted flap 105 returns to the position in which it covers the outlet 105a. The reduced pressure within the chamber 107 causes the inlet valve to be opened,

i.e. the valve member 108a of the plunger 108 is displaced from the valve seat 110 and the contents of the container are drawn into the chamber 107 to replenish the contents previously dispensed.

In a preferred embodiment, the plunger would be replaced with the plunger shown in Figure 9C, thereby additionally providing the device 100 with an air leak valve.

Referring to Figure 2A and 2B, there is shown a second embodiment of a device 200 of the present invention. This second embodiment is the same as the embodiment shown in Figure 1 in many respects and this is illustrated by the use of the same reference numerals to denote like or corresponding parts. There is, however, one principal difference in that the housing 102 is formed to define a chamber 107 that is composed of two separate, internally-sealed compartments. The central compartment 107a is equivalent to the chamber 107 shown in Figure 1 in that the contents of the container pass through it during use. The circular wall 201 of the housing 102 defines the central compartment 107a. This wall 201 is received within a corresponding circular recessed groove 202 formed in the upper surface of the base 101. Thus, during use the wall 201 slides within the recessed groove 202. The chamber 107a comprises a smaller plunger 108 and a spring 111, the functions of which are identical to that described in reference to Figures 1A and 1B.

The second compartment is an air chamber 203 which surrounds the

central compartment 107a. The air compartment 203 is defined between the outside wall of the housing 102 and the inner wall 201. An air plunger 204 is seated on the base within the air compartment 203 and performs the same function as the plunger 108 described in reference to Figure 1. In this embodiment, the air plunger 204 is circular in shape and comprises a recess 205 formed in its under surface which, when seated onto the base in the final assembly, as shown in Figure 2A, receives the upright protrusion 206 formed on the base. A plan view of the upper surface of the base 101 is shown in Figure 4 to illustrate the arrangement of the respective recesses and protrusions.

The air chamber 203 comprises an outlet channel 204 which connects the air chamber 203 to a position along the length of the internal passageway 106, such that air ejected from the air chamber 203 when the housing of the device is displaced towards the base thereby comprising the chambers 107 and 203) entering the internal passageway 106 downstream from the outlet valve and is dispensed with the liquid dispensed from the chamber 107.

An air release valve (not shown) is provided in the outlet channel 204. The valve is a two way valve adapted to open and permit air to be dispensed from the chamber 203 only when a predetermined minimum pressure is achieved therein. The valve is preferably configured to open at the same time as the outlet valve so that the liquid dispensed from the chamber 107 is simultaneously released with air from the air chamber. This ensures that the air and liquid mix within the internal passageway 106.

In alternative embodiments of the invention, the housing 102 may be wider than the base and configured so that the outer wall of the housing slides over the outer wall of the base. This construction is preferred for embodiments of the invention which comprise an air leak, as discussed further below in reference to Figure 9C.

For the purpose of illustration, housing 102 of the embodiment shown in Figure 2 is shown in Figures 3A and 3B. Referring to these Figures, it can be seen that the housing has two outlets formed in its upper surface, namely the initial portion of the internal passageway 106a, and the outlet channel 204 through which the contents of the air chamber 203 are ejected during use into the internal passageway 106 defined between the lid 104 and the upper surface of the first part 102c of the housing 102.

The plunger 108 of the embodiment shown in Figures 2A and 2B is shown in more detail in Figures 5A and 5B. The upper portion of the plunger 108 is shaped to form two tight sealing engagements with the wall 201 of the central chamber 107a when positioned within the assembled device, as shown in Figure 2A. Specifically, a first seal, which prevents air leaking past the plunger during the second stage of operation, is formed by the edge 501 contacting the wall of the housing 201. A second seal, which prevents air leaking past the plunger during the first stage of operation, is formed by the contact of the edge 502 with the housing 201. If the second seal was not present, the edge 501 could be displaced from contact with the housing during

the first stage of operation of the device by the pressure difference between the interior of the compartment and the outside environment, thereby causing air to flow into the compartment 107a, instead of product being drawing in through the inlet valve. The plunger also has a downwardly extending valve member 108a which terminates in a truncated cone which is received within the aperture defined by the valve seat 109 of the base 101 to form the inlet valve.

The upper portion of the housing 102 is shown in more detail in Figures 6A and 6B. Fitted to the upper surface of a first part of the housing 102c is a lid 104. The lid is composed of two parts, a body 601 which is adapted to be fitted to the upper portion of the housing 102 and a hinged lid portion 602. The hinged lid portion 602 has the resiliently deformable flap 105a formed on its under surface which, when the lid is brought together with the body 601, forms the outlet valve, as previously described. The hinged lid portion 602 also has an abutment surface having grooves and/or recesses formed thereon which, when the lid is contacted with a corresponding abutment surface formed on the upper surface of the housing 102 which has corresponding grooves and/or recesses formed thereon, defines the nozzle outlet 106.

A plan view of abutment surface of the upper surface of the housing 102 is shown in Figure 7A. The abutment surface 701 comprises an aperture which extends to the internal chamber 107a and forms an initial portion 106a of the internal passageway and a groove 702 which extends from the second valve to an edge of the abutment surface 703. Formed within the groove 702 is a

deepened recess 704. The recess 704 is shown in more detail in Figure 7B where it can be seen that the recess is semicircular in cross-sectional profile and the channel 204 that extends from the air chamber 203 into the recess. The abutment surface of the lid 602 (not shown) comprises a similar groove to the groove 702 with an equivalent a recess equivalent to the recess 704 formed therein. Thus, when the two abutment surfaces are brought into contact, the grooves and recesses formed therein align to form a fluid flow passageway which extends from the second valve to the outlet 703 of the device and comprises a circular chamber formed by the alignment of the recess 704 and the corresponding recess of the abutment surface of the lid 602. The chamber thus formed is known as an expansion chamber. In use, the contents of the internal chamber 107a passes through the second valve into the passageway formed by the groove 702 and its equivalent on the opposing abutment surface of the lid 104. The fluid is then sprayed into the expansion chamber (see reference 710 in Figure 7C) formed by the recess 704 and the corresponding recess in the opposing abutment surface of the lid through an orifice formed in the passageway (not shown). The spray droplets thus formed mix with an air stream ejected from the air chamber 203 in the expansion chamber 710 and then continue along the passageway to the outlet 112 where they are ejected from the device in the form of a spray.

To prevent the occurrence of leaks, the fluid outlet arrangement is surrounded by a horseshoe-shaped recess 705 formed in the abutment surface

of the housing 102 which receives a correspondingly shaped protrusion 706 (see Figure 7C) formed on the abutment surface of the lid, as shown in Figure 7C, to form a horseshoe-shaped seal barrier. In a similar manner, further recesses 707 extend from either side of the horseshoe-shaped recess 705 towards the groove 702 at various points along the length of the groove 702. These further recesses also receive correspondingly shaped protrusions on the abutment surface of the lid and, together with the horseshoe-shaped seal barrier, define a series of internally sealed compartments around portions of the fluid flow passageway when the abutment surfaces of the upper surface of the housing 102 and the lid 602 are brought into contact. Any fluid that leaks from the fluid flow passage during use is then trapped within one of these compartments and prevented from seeping between the abutment surfaces and leaking from the nozzle outlet.

The channel 204 is shown in Figures 7A and 7B as a direct channel between the air chamber 203 (not shown) and the internal passageway 106 of the nozzle outlet. Where the nozzle outlet is formed between the abutment surfaces of two or more parts, as shown in Figures 7A and 7B, it shall be appreciated that the air can be conveniently channelled to virtually any point along the length of the fluid flow passage that is desired by positioning the opening of the outlet channel 204 so that air enters the channel where it is desired.

Figure 7C is a cross-sectional view taken along line X-X' of Figure 7A.

In Figure 7C the horseshoe-shaped recesses 705 and the horseshoe-shaped protrusion 706, which form the horseshoe shaped seal, are visible on either side of the expansion chamber 710. The fluid flow passage 711 which opens to the expansion chamber 710 is also shown.

An alternative embodiment of the lid 104 is shown in Figure 8. In this embodiment, the lid 104 is fitted to the upper surface of the first part 102c housing 102 shown in Figures 1A and 1B in the usual manner. The initial portion of the internal passageway 106a formed by first part 102c of the housing 102 is covered by a resiliently deformable membrane 801, which is integrally formed in the lid 104, and has a downwardly extending plug 802 which is received within the upper portion of the initial portion of the passageway 106a. The membrane 801 and plug 802 effectively form an alternative form of valve member for the outlet valve of the device. During use, i.e. when the housing is pushed towards the base 101 to eject the contents of the chamber through the internal passage 106 and the outlet 112, the pressure within the chamber increases to a predetermined threshold level and, once this level is attained or exceeded, the membrane 801 is caused to deform away from the opening of the portion of the passageway 106a thereby withdrawing the plug 802 and forming an opening through which the contents of the chamber may flow to the outlet 106. After use, i.e. when the pressure falls below the minimum threshold, the membrane returns to its original position in which the channel 301 is closed, as shown in Figure 8.

Figure 9A shows a modification to the air plunger 204 and base 101 shown in Figures 2A and 2B which provides an air leak to equalise any pressure differential that develops between the interior of the container and the external environment. Only the relevant portion of the device is shown in Figure 9A for the purpose of illustration. As previously discussed in reference to Figures 2A and 2B, the housing 102 is slidably mounted in a recess 103 of the base 101 and an air plunger 204 is seated on a protrusion ridge 206 formed in the base 101. As shown in Figure 9A, the air plunger 204 is modified to include a downwardly extending resiliently mounted arm 901 which contacts the internal wall of the housing. The resiliently mounted arm 901 is positioned adjacent to an air leak opening 902 formed within the base and is capable of movement between a position in which said arm covers and closes the air leak opening and a position in which the air leak is open, thereby enabling air to flow between the external environment and the interior of the container. As can be seen in Figure 9A, the resiliently mounted arm 901 of the plunger 204 can be urged into the closed position by an enlarged annular rim 903 at the base of the internal wall of the housing 101, which urges the resiliently mounted arm into a position in which the air leak is closed when the device is not in use. When the housing is pushed downwards relative to the base, the arm 901 of the air plunger 204 is resiliently biased to still seal the opening 902, whereas when the housing moves upwards relative to the base, the arm 901 is displaced from the opening 902 and air can pass through the opening until the rim 903 urges

the arm 901 back towards the opening to reform the seal.

Figure 9B shows yet another alternative embodiment of the device of the present invention which comprises an air leak formed therein. The embodiment shown in figure 9B is similar to that shown in Figures 2A and 2B in certain respects. However, this embodiment differs in that the central compartment 107a of the chamber is provided with a plunger of different construction to the plunger 108. In this embodiment, the plunger in the central cavity 107a is shown by the reference 910 and a separate valve member 911 is received within the valve seat 109 of the base 101 to form the first valve. A ledge or set of post 912 onto which the spring 111 is mounted is provided between the valve member 911 and the plunger 910. A further modification is that the second valve is formed by a resiliently deformable membrane 801 having a downwardly extending member 802 which is received within the outlet channel 301, rather than the flap 105 which covers the opening 105a previously described.

The air plunger 204 is also of a different form but, in common with the embodiment shown in Figure 9A, comprises a resiliently mounted arm 901 which is also capable of being urged from a position in which the arm is displaced from an air leak opening 902 formed in the base and the air leak is open, to a position in which the air leak 902 is closed. Again, the arm 901 of the air plunger 204 is urged into the position whereby the air leak 902 is closed when an enlarged rim 903 formed at the base of the internal wall of the housing

102 slides past the arm 901. Hence, when the housing is pressed down relative to the base, as shown in Figure 9B, the air leak is open, but if the housing is released so that the spring 111 pushes the housing upwards until the rim 102a abuts the rim 101a, then the arm is urged into the position whereby the air leak is closed by the enlarged rim 903.

Figure 9C shows a further alternative embodiment of the device, which comprises an air leak. In this embodiment, the outer wall of the housing slides over the outer surface of the base when the housing is pushed down relative to the base, rather than being slidably mounted within a recessed groove formed in the upper surface of the base, as in all of the previous embodiments. In this embodiment, the air plunger 204 is in the form of a wedge which possesses two arms. A first arm 901 contacts the side of the base to form a seal to close the air leak 902 formed in the base, whereas the second arm 920 forms a tight sealing engagement with the internal wall of the air compartment 203. The seal formed by the arm 901 is only very light and this are can be deflected to a position in which the air leak is open if the external pressure exceeds the pressure within the container. The leakage of the contents of the container out of through the air leak 902 is prevented, however, because the arm 902 forms a seal against the wall of the base as shown in Figure 9C and cannot be deflected further to enable flow to occur out of the container.

Figures 10A and 10B show a container 1000 fitted with a device 100 of the present invention which is provided with a trigger actuator 1001. The

trigger actuator 1001 is composed of two pivotally connected parts 1002 and 1003 connected together by a plastic hinge at 1004. Part 1002 consists of an attachment element 1002a which is pivotally connected to the base of the device and a trigger 1002b which can be operated by a user in the normal manner. Part 1003 is pivotally mounted to the lid 104 of the housing 102. Operation of the trigger by pulling it towards the container pulls the part 1002 downwards about the pivotal connection to the base and this action in turn causes the part 1003 to pull the housing downwards relative to the base, (thus compressing the chamber therein and causing the product, or a mixture of product and air (if an air chamber is present), to be dispensed through the nozzle outlet).

The housing 102 and plunger 108 of an alternative embodiment of the present invention is shown in Figure 11. This embodiment is the same as that shown in Figures 1A and 1B except that the plunger 108 comprises upwardly and outwardly extending wall 108b which defines a liquid containing, resiliently deformable insert or compartment 107a within the chamber 107. The upwardly and outwardly extending wall 108b is resiliently deformable so that when the housing 102 is displaced towards the base 101 (not shown in Figure 11) the wall will deform/collapse so that the pressure within the compartment 107a increases and fluid present therein will be dispensed through the internal passageway 106 and the outlet when the pressure is sufficient to open the outlet valve. In this embodiment the resilient deformable wall/insert 108b is the

resilient means which, instead of the spring 111 and post 102b required in the embodiment shown in Figures 1A and 1B, forces the housing 102 away from the base 101 to cause the volume of the chamber to increase when the actuator is not operated, or it is released after operation.

A further alternative embodiment of the present invention is shown in Figures 12A and 12B. This embodiment is identical to the embodiment described in reference to Figure 11, except that the resiliently deformable insert or wall 108b is formed as a resiliently deformable bellows or concertina, which compresses when the chamber 107 is compressed by the operation of the actuator (i.e. pressing the housing downwards towards the base 101) and subsequently returns to its original configuration, as shown in Figures 12A and 12B, when the pressure applied to the actuator is released.

The embodiments of the invention shown in Figures 11, 12A and 12B, are the simplest embodiments of the present invention comprising only three separate component parts, namely the base 101, the housing 102 (including the lid 104) and the insert/valve member 108. Accordingly, these embodiments will be particularly cheap to produce.

A further modified embodiment of the invention is shown in Figure 13. This embodiment is identical to that shown in Figures 12A and 12B, except that an additional resiliently deformable bellows or concertina insert 1301 is provided inside the insert 108b. In this embodiment, the compartment 107a

forms an air chamber, equivalent to the air chamber 203, and the inner compartment 1302 contains the liquid drawn in through the inlet. Liquid drawn in through the inlet is transferred into the internal compartment 1302 through the stem 1303 of the plunger 801.

A further alternative embodiment of the present invention is shown in Figure 14. In this embodiment a resiliently deformable insert 1401 is positioned within the internal chamber 107 defined between the first part of the housing 102c and the base 101. The insert 1401 is formed by two interconnected sections 1401a and 1401bwhich define a central compartment/chamber 1302 and an outer air compartment/chamber 203/107a. The insert 1401 also defines a one-way inlet valve 1402, a one-way outlet valve 1403, a one-way air release valve 1404, a one-way air inlet valve 1405 and a one-way air release valve.

Thus, when the housing 102 is pushed downwards towards the base 101 (i.e. when the actuator is operated), the insert is compressed and the pressure within the chambers 1302 and 203/107a increases, thereby causing the valves 1403 and 1404 to open when the pressure within the chambers exceed the minimum threshold pressure, and the fluid and air present in these chambers to be ejected through the internal passageway 106 to outlet 112. Once the desired amount of the fluid has been released, or the housing 102 has been depressed its fullest extent, the applied pressure is released (i.e. the actuator is released) and the insert then urges the base 101 and the housing 102 apart due to its inherent

resiliency. This causes more fluid to be drawn into the chamber 1302 through the inlet valve 1402 and more air to be drawn into the air chamber through the air inlet valve 1405. Any pressure differential between the interior of the container and the external environment will be equalised through the air release valve.